Title: **Vibration-Reducing System for Data Access Apparatus**

Inventor: **CHOU, Chen-Wang**

[0001] This application claims priority of Taiwan Patent Application No.091118155 filed on August 13, 2002.

Field of Invention

[0002] The present invention relates to a vibration-reducing system for reducing vibration of a data access apparatus, which is generated by an impact.

Background of the Invention

[0003] On the ground of the increased request of precision, data access apparatus are getting more brittle today. Therefore, reducing the effect of external impacts is brought into an important issue regarding the durability of data access apparatuses, such as hard disks having high operation speed.

[0004] Comparing with other hard disks, the vibration-control requirements of the hard disks disposed on portable computers are relative high. The requirements are on the ground that those hard disks have to meet frequently movements, and the movement is a main reason to damage the hard disks. In addition, even though

other desktop computers are not frequently moved, however, the vibration control of the hard disks of these desktops are also important due to the increase of operation speed.

[0005] Accordingly, the vibration-control problems of hard disks still exist and need to be solved, no matter the hard disks are disposed on portable computers or desktop computers.

Summary of the Invention

[0006] It is an aspect of the present invention to reduce vibration of a data apparatus generated by an impact.

[0007] It is another aspect of the present invention to remove a part of energy of the data apparatus generated by an impact.

[0008] It is another aspect of the present invention to reduce a high-frequency vibration, which is generated during the operation of the data access apparatus, transmitted to a data processing apparatus.

[0009] The present invention provides a vibration-reducing system for use with a data processing apparatus, which has a data access apparatus. The data processing apparatus includes a body, which has a depression. The vibration-reducing system includes at least one first elastic element and at least one second elastic element. The first elastic element connects the

data access apparatus to the body allowing the data access apparatus being suspended within the depression. The second elastic element includes a first surface and a second surface. The first surface connects to the body, and the second surface contacts with the data access apparatus.

[0010] The first elastic element has flexibility in bending, vertical extension and compression. The second elastic element has one-dimensional flexibility. The second elastic element has an elastic modulus, which is smaller than the elastic modulus of the first elastic element. While the body is impacted to generate an initial energy and a displacement, the data access apparatus stretches or bends the first elastic element and compresses the second elastic element. Then a damping effect is generated on the ground of a difference between the elastic modulus of the first and the second elastic elements. The damping effect helps to remove a part of the initial energy from the data access apparatus.

[0011] This and other aspects of the present invention will become clear to those of ordinary skills in the art after having read the following detailed description of the preferred embodiments illustrated in the various figures and drawings.

Brief Description of the Drawings

[0012] Fig. 1 shows an embodiment of the present invention;

[0013] Fig. 2 shows an explosive view of the embodiment of Fig. 1;

[0014] Fig. 3a shows a profile of the embodiment of Fig. 1;

[0015] Fig. 3b shows a profile of the embodiment of Fig. 1 when the first elastic element is stretched;

[0016] Fig. 3c shows a profile of the embodiment of Fig. 1 when the first elastic element rebounds;

[0017] Fig. 4a shows a profile of the embodiment of Fig. 1 when the first elastic element is bended;

[0018] Fig. 4b shows a profile of the embodiment of Fig 1 when the first elastic element rebounds;

[0019] Fig. 5 shows another embodiment of the present invention;

[0020] Fig. 6 shows a flow chart of an embodiment of the vibration-reducing method of the present invention; and

[0021] Fig. 7 shows a flow chart of another embodiment of the vibration-reducing method of the present invention.

Detailed Description

[0022] The present invention provides a vibration-reducing system for use with a data processing apparatus 100, which

has a data access apparatus 200. As Fig. 1 shows, the data processing apparatus 100 includes a body 110, which has a depression 111 for containing the data access apparatus 200. When the body 110 is impacted, such as being struck, the vibration-reducing system is configured for reducing the generated vibration.

[0023] In preferred embodiment, the data access apparatus 200 includes a hard disk. However, the data access apparatus 200 may includes other device such as a floppy drive, disk displayer, memory or others. In addition, the data processing apparatus 100 includes a portable computer. However, the data processing apparatus 100 may includes personal computer (PC), personal digital assistant (PDA), mobile phone or others which may cooperate with the data access apparatus 200.

[0024] Fig. 2 shows an explosive view of an embodiment of the present invention. The vibration-reducing system includes at least one first elastic element 300 and at least one second elastic element 400. A first end of the first elastic element 300 connects with the data access apparatus 200, and a second end of the first elastic element 300 connects with the body 100. In this embodiment, the second end of the first elastic element 300 connects with a top surface of the depression 111. The data access apparatus 200 is suspended within the depression 111 by

using the first elastic element 300. The preferred embodiment of the first elastic element 300 includes a spring, and other embodiments of it include an elastic rubber, a sponge and others.

[0025] In a preferred embodiment, a vibration absorbing spacer 600 is disposed between the first elastic element 300 and the data access apparatus 200. While the data access apparatus is operating, a high-frequency vibration is generated and transmitted to the body 110. The spacer 600 is used to absorb the vibration so that the strength of the vibration, which is transmitted to the data access apparatus 200, is reduced. The preferred embodiment of the spacer 600 is made of rubber. But in other embodiments, the spacer 600 may be made of sponge or polymer materials.

[0026] The first elastic element 300 has flexibility in bending, vertical extension and compression. Therefore, the data access apparatus 200 is capable of moving relative to the body 110 in a 3-dimensional space by bending, stretching or compressing the first elastic element 300. However, the movement of the data access apparatus 200 is limited to the space of the depression 111. When the body 110 is impacted, the data access apparatus 200 may move corresponding to the impaction force. It should be noted that, in the preferred embodiment, the first elastic element 300 merely has flexibility in bending and vertical

extension.

[0027] In the preferred embodiment, the data access apparatus 200 is a cube, and four first elastic elements 300 are respectively disposed to connect with the four corners of the cube. However, in other embodiments, the amount and the disposed position may be adjusted according to different conditions, such as a different shape of the data access apparatus 200.

[0028] As Fig. 2 shows, the second elastic element 400 is disposed between the body 110 and the data access apparatus 200. The second elastic element 400 includes a first surface 410 and a second surface 420 opposite to the first surface 410. The first surface 410 connects with the body 110 and the second surface 420 contacts with the data access apparatus 200. In the preferred embodiment, the second elastic element 400 includes a vibration-absorptive material, such as PU polymer, rubber, sponge or other alike.

[0029] The second elastic element 400 has one-dimensional flexibility. In the preferred embodiment, the direction of the flexibility is vertical or perpendicular to the first surface 410 or the second surface 420. However, the second elastic element 400 may also be bended or compressed in other directions.

[0030] Moreover, the second elastic element 400 has an

elastic modulus, which is smaller than the elastic modulus of the first elastic element 300. In other words, the first elastic element 300 provides a reaction force and a rebound speed, which exceed those provided by the second elastic element 400, while the first elastic element 300 and the second elastic element 400 are compressed or stretched with the same displacement. It should be noted that the elastic modulus mentioned here includes that of stretch, compression and bending.

[0031] In the preferred embodiment, the data access apparatus 200 is a cube, and six second elastic elements 400 are respectively disposed to connect with the six surfaces of the cube. However, in other embodiments, the amount and the disposed position may be adjusted according to different conditions, such as a different shape of the data access apparatus 200.

[0032] While the body 110 is impacted, an initial energy and corresponding displacement of the data access apparatus 200 are generated. The displacement forces the data access apparatus 200 to stretch or bend the first elastic element 300 and compress the second elastic element 400. Then a damping effect is generated due to a difference between the elastic modulus of the first and the second elastic elements 300, 400. The damping effect mentioned here may be interpreted as an effect for

exhausting the system energy. The damping effect helps the vibration-reducing system to remove a part of the initial energy from the data access apparatus 200.

[0033] Fig. 3a, Fig. 3b and Fig. 3c are used to illustrate the damping effect. Fig. 3a shows a profile of the vibration-reducing system while the body has not been impacted. In the meantime, the first elastic element 300 is in the natural state and merely bearing the weight of the of the data access apparatus 300.

[0034] As Fig. 3b shows, while the body 110 is impacted to generate the initial energy, the displacement of the data access apparatus 200 is generated to stretch the first elastic element 300 and to compress the second elastic element 400. In the meantime, a part of the initial energy is transmitted to the first elastic element 300 as a first potential energy, and another part of the initial energy is transmitted to the second elastic element as a second potential energy. In this embodiment, under a unique-displacement condition, the first potential energy is larger than the second potential energy, because the elastic module of the first elastic element 300 is larger than that of the second elastic element 400.

[0035] Then, as Fig. 3c shows, the first potential energy provides the data access apparatus 200 with a rebound energy and a rebound speed. In other words, a part of

the first potential energy is transmitted back to the data access apparatus 200 as a kinetic energy, which provides the rebound speed. The rebound speed exceeds a returning speed of the second elastic element 400 to separate the second surface 420 of the second elastic element 400 from the data access apparatus 200. This prevents the second potential energy from transmitting back to the data access apparatus 200. Accordingly, a part of the initial energy is removed from the data access apparatus 200.

[0036] Fig. 4a and Fig. 4b show another embodiment of the damping effect. As Fig. 4a shows, while the body 110 is impacted to generate the initial energy, the displacement of the data access apparatus 200 is generated to bend the first elastic element 300 and to compress the second elastic element 400. In the meantime, a part of the initial energy is transmitted to the first elastic element 300 as a first potential energy, and another part of the initial energy is transmitted to the second elastic element as a second potential energy. In this embodiment, under a unique-displacement condition, the first potential energy is larger than the second potential energy, because the elastic module of the first elastic element 300 is larger than that of the second elastic element 400.

[0037] Then, as Fig. 4b shows, the first potential energy

provides the data access apparatus 200 with a rebound energy and a rebound speed. In other words, a part of the first potential energy is transmitted back to the data access apparatus 200 as a kinetic energy, which provides the rebound speed. The rebound speed exceeds a returning speed of the second elastic element 400 to separate the second surface 420 of the second elastic element 400 from the data access apparatus 200. This prevents the second potential energy from transmitting back to the data access apparatus 200. Accordingly, a part of the initial energy is removed from the data access apparatus 200.

[0038] Fig. 5 shows an explosive view of another embodiment of the present invention. As Fig. 5 shows, the body 110 further includes a frame 500, which is contained within the depression 111 and separably coupled to an inner surface of the depression 111. The first elastic element 300 connects to both the frame 500 and the data access apparatus 200 so that the data access apparatus 200 is suspended from the frame 500. The second elastic element 400 is disposed between the frame 500 and the data access apparatus 200, and the first surface 410 of the second elastic element 400 connects to the frame 500. When a user intends to draw out the data access apparatus 200 from the body 110, all he or she has to do is separating the frame 500 from the inner surface of the depression

111.

[0039] As Fig. 5 shows, the body 110 further includes a cover 700 corresponding to the depression 111 for covering the data access apparatus 200. At least one second elastic element 400 is disposed between the cover 700 and the data access apparatus 200. The first surface 410 of the second elastic element 400 connects to an inner surface 710 of the cover 700, and the second surface 420 of the second elastic element 400 contacts with the data access apparatus 200. When a user intends to draw out the data access apparatus 200 from the body 110, he or she merely need to open the cover 700 rather than to disassemble the body 110.

[0040] The present invention also provides a method for applying on the vibration-reducing system mentioned above. This method is used for removing a part of the initial energy to reduce the vibration of the data access apparatus 200.

[0041] As Fig. 6 shows, the first step, step (a), includes moving the data access apparatus 200 with a displacement corresponding to the initial energy. In this embodiment, the initial energy provides the data access apparatus 200 with a speed to generate the displacement.

[0042] In step (b), corresponding to the displacement, the data access apparatus 200 stretches or bends the first

elastic element 300 and compresses the second elastic element 400. Under a unique-displacement condition, the rebound force provided by the first elastic element 300 is larger than that of the second elastic element 400, because the elastic module of the first elastic element 300 is larger than that of the second elastic element 400.

[0043] Then in step (c), a damping effect is generated on the ground of a difference between the elastic modulus of the first and the second elastic elements 300, 400 to remove a part of the initial energy from the data access apparatus 200.

[0044] In another embodiment shown as Fig. 7, step (c) further includes, first, transmitting a part of the initial energy to the first elastic element 300 as a first potential energy, and transmitting another part of the initial energy to the second elastic element 400 as a second potential energy. In this embodiment, under a unique-displacement condition, the first potential energy is larger than the second potential energy, because the elastic module of the first elastic element 300 is larger than that of the second elastic element 400.

[0045] Then the first potential energy is transmitted to the data access apparatus 200 as a rebound energy, which provides the data access apparatus 200 with a rebound speed. The rebound speed exceeds a returning speed of the second

elastic element 400.

[0046] Then the rebound speed separates the data access apparatus 200 from the second elastic element 400 to prevent the second potential energy from transmitting back to the data access apparatus 200. Accordingly, a part of the initial energy is removed from the data access apparatus 200 to reduce the vibration of the data access apparatus 200.

[0047] Those skilled in the art will readily observe that numerous modifications and alterations of the device may be made within the teaching of the invention. Accordingly, the above disclosure should be construed as limited only by the metes and bounds of the appended claims.